CLAIMS

1. A means for switching data, the means comprising:

- a data bus,
- a plurality of devices adapted to exchange data with each other via the data bus, each device being adapted to receive data from and transmit data to at least one corresponding I/O port, at least one first device being adapted to receive data from and transmit data to a plurality of corresponding I/O ports,
- arbiter means for determining an order of exchanging, on the data bus, of data between the devices,

the devices being adapted to:

- receive and store data from a corresponding I/O port,
- transmit, to the arbiter, information relating to congestion or availability of a corresponding port,
- receive, from the arbiter, information indicating whether the received data may be transmitted over the data bus,
- transmit, if the information received indicates that the data may be transmitted, the data over the data bus, and
- receive data from the data bus and forward the received data to a corresponding I/O port,

the arbiter being adapted to:

- receive, from the devices, the congestion or non-availability information, and
- determine the order of exchanging data on the basis of the congestion information.

2. A means according to claim 1, wherein a plurality of the devices are adapted to exchange data with each other directly over the data bus at at least substantially the same rate.

3. A means according to claim 2, wherein a first number of the I/O ports enable a highest first, higher data receiving/transmitting rate, and a second number of the I/O ports enable a highest second, lower data receiving/transmitting rate being lower than the higher rate.

4. A means according to claim 3, wherein at least one I/O port further enables one or more other data receiving/transmission rate(s) being lower than its highest data rate.

5. A means according to claim 3, wherein each device is able to receive data from the data bus and transmit data to the data bus at at least the first rate.

6. A means according to claim 3, wherein each device is operationally connected to either one or more of the I/O ports of the first group or a plurality of the I/O ports of the second group.

7. A means according to claim 1, wherein at least one second device comprises a memory means comprising a number of data queues for holding data packets or frames received from the one or more corresponding I/O ports and/or from the data bus.

8. A means according to claim 7, wherein the memory means has one or more data queues for each of the corresponding I/O port(s).

9. A means according to claim 7, wherein the at least one second device further comprises an interface which may be altered between a first embodiment having a first combination of first and second I/O ports and a second embodiment having a second combination of first and second I/O ports, the memory means being adapted to provide, in each of the first and second embodiments, one or more queues for each I/O port embodied by the interface.

10. A means according to claim 9, wherein the interface, in the first embodiment, has a plurality of the second I/O ports and, in the second embodiment, has one or more of the first I/O ports, the memory means being adapted to, in the first embodiment, comprise a first number of queues per first I/O port of the interface and, in the second embodiment, comprise a second number of queues per second I/O port of the interface.

11. A means according to claim 1, wherein the arbiter is adapted to receive information relating to each piece of data received at the I/O ports, the information comprising an I/O port and/or a device to receive the piece of data.

12. A means according to claim 1, wherein the arbiter is adapted to provide, to the at least one first device, information relating to which of the corresponding ports is allowed to transmit data.

13. A means according to claim 12, wherein the arbiter is adapted to examine, for the at least one first device, whether a first port of the plurality of ports wishes to transmit data to a congested or non-available port and to, if so, examine whether another port of the plurality of ports wishes to transmit data to a non-congested or available port and, if so, transmit, to the at least one first device, information relating to the other port being allowed to transmit data.

14. A means according to claim 1, wherein the at least one first device is adapted to determine to which of its corresponding I/O port to transmit data received from the data bus.

15. A means according to claim 1, wherein a device is adapted to determine congestion at a corresponding I/O port and to transmit corresponding information to the arbiter, and wherein the arbiter is adapted to override any congestion or non-availability of a receiving device or I/O port when a congested I/O port wishes to transmit data thereto, and inform the pertaining device that the congested I/O port is allowed to transmit data.

16. A means according to claim 1, wherein each device is adapted to transmit all pieces of data received at the corresponding I/O ports to the data bus.

17. A means according to claim 1, wherein at least one third device further comprises a processing means adapted to:

- provide a priority for each piece of data received at its I/O port(s),
- divide each piece of data received at its I/O port(s) into cells before transmission thereof to the data bus and to assemble cells received from the data bus into pieces of data before outputting from an I/O port,
- process each piece of data received at an I/O port, and/or
- derive, from each piece of data received at an I/O port, information for transmission to the arbiter.

18. A means according to claim 17, wherein the device comprises a processing means for each I/O port of the device.

19. A means according to claim 17, wherein the at least one third device has means for providing a priority for each piece of data received at its corresponding I/O port(s), and wherein the arbiter is adapted to determine the order of exchanging data also on the basis of the priority of the data.

20. A means according to claim 1, further comprising a Look-Up Engine adapted to receive information relating to each piece of data received at an I/O port and to derive, from the information, identifying information relating to one or more I/O port(s) or device(s) to receive the piece of data.

21. A means according to claim 20, wherein each device is further adapted to derive, from each piece of data received, information relating to the piece of data, to transmit the information to the LU Engine, receive identifying information from the LU Engine, and to exchange the identifying information on the data bus together with the piece of data.

22. A means according to claim 20, wherein the data and identifying information is stored subsequent to receipt of the identifying information and prior to exchange thereof on the data bus.

23. A means according to claim 20, wherein at least one fourth device is adapted to, on the basis of the identifying information, determine whether the data is addressed for the device or not.

24. A means according to claim 20, wherein the arbiter is adapted to, when more than one port or device is to receive a piece of data received at a receiving device, determine which of the ports and devices are available or non-congested and transmit information to the receiving device in order to have it forward the data to those ports and devices, and subsequently, when other of the ports or devices are available or non-congested, inform the receiving device to forward the data to those devices or ports.

25. A method of switching data in a switching means comprising:

- a data bus,
- a plurality of devices adapted to exchange data with each other via the data bus, each device being adapted to receive data from and transmit data to at least one corresponding I/O port, at least one first device being adapted to receive data from and transmit data to a plurality of corresponding I/O ports, and
- arbiter means for determining an order of exchanging, on the data bus, of data between the devices,

the method comprising the each device:

- receiving and storing data from a corresponding I/O port,
- transmitting, to the arbiter, information relating to congestion or availability of a corresponding port,
- receiving, from the arbiter, information indicating whether the received data may be transmitted over the data bus,
- transmitting, if the information received indicates that the data may be transmitted, the data over the data bus, and
- receiving data from the data bus and forward the received data to a corresponding I/O port,

and the arbiter:

- receiving, from the devices, the congestion or non-availability information, and
- determining the order of exchanging data on the basis of the congestion information.

26. A method according to claim 25, wherein a plurality of the devices exchange data with each other directly over the data bus at at least substantially the same rate.

27. A method according to claim 26, wherein a first number of the I/O ports enable a highest first, higher data receiving/transmitting rate, and a second number of the I/O ports enable a highest second, lower data receiving/transmitting rate being lower than the higher rate.

28. A method according to claim 27, wherein at least one I/O port further enables one or more other data receiving/transmission rate(s) being lower than its highest data rate.

29. A method according to claim 27, wherein each device receives data from the data bus and transmits data to the data bus at at least the first rate.

30. A method according to claim 27, wherein each device communicates with either one or more of the I/O ports of the first group or a plurality of the I/O ports of the second group.

31. A method according to claim 25, wherein at least one second device stores pieces of data received from the one or more corresponding I/O ports and/or from the data bus in a memory means comprising a number of data queues for holding pieces of data.

32. A method according to claim 31, wherein the at least one second device stores the pieces of data in one or more data queues for each of the corresponding I/O port(s).

33. A method according to claim 31, wherein the at least one second device further comprises an interface which alters between a first embodiment, having a first combination of first and second I/O ports, and a second embodiment, having a second combination of first and second I/O ports, the memory means providing, in each of the first and second embodiments, one or more queues for each I/O port embodied by the interface.

34. A method according to claim 33, wherein the interface, in the first embodiment, has a plurality of the second I/O ports and, in the second embodiment, has one or more of the first I/O ports, the memory means, in the first embodiment, comprising a first number of queues per first I/O port of the interface and, in the second embodiment, comprising a second number of queues per second I/O port of the interface.

35. A method according to claim 25, wherein the arbiter receives information relating to each piece of data received at the I/O ports, the information comprising an I/O port and/or a device to receive the piece of data.

36. A method according to claim 25, wherein the arbiter provides, to the at least one first device, information relating to which of the corresponding ports is allowed to transmit data.

37. A method according to claim 36, wherein the arbiter examines, for the at least one first device, whether a first port of the plurality of ports wishes to transmit data to a congested or non-available port and to, if so, examines whether another port of the plurality of ports wishes to transmit data to a non-congested or available port and, if so, transmits, to the at least one first device, information relating to the other port being allowed to transmit data.

38. A method according to claim 25, wherein the at least one first device determines to which of its corresponding I/O ports to transmit data received from the data bus.

39. A method according to claim 25, wherein a device determines congestion at a corresponding I/O port and transmits corresponding information to the arbiter, and wherein the arbiter overrides any congestion or non-availability of a receiving device or I/O port when a congested I/O port wishes to transmit data thereto, and informs the pertaining device that the congested I/O port is allowed to transmit data.

40. A method according to claim 25, wherein each device transmits all pieces of data received at the corresponding I/O ports to the data bus.

41. A method according to claim 25, wherein at least one third device further comprises one or more of the processing steps of:

- providing a priority for each packet or frame received at its I/O port(s),
- dividing each packet or frame received at its I/O port(s) into cells before transmission thereof to the data bus and assembling cells received from the data bus into frames or packets before outputting from an I/O port,
- processing each packet or frame received at an I/O port, and
- deriving, from each packet or frame received at an I/O port, information for transmission to the arbiter.

42. A method according to claim 41, wherein the at least one third device performs one or more processing steps for each I/O port of the device.

43. A method according to claim 41, wherein the at least one third device performs the step of providing a priority for each piece of data received at its corresponding I/O port(s), and wherein the arbiter determines the order of exchanging data also on the basis of the priority of the data.

44. A method according to claim 25, further comprising the step of a Look-Up Engine receiving information relating to each piece of data received at an I/O port and deriving, from the information, identifying information relating to one or more I/O port(s) or device(s) to receive the piece of data.

45. A method according to claim 44, wherein each device further derives, from each piece of data received, information relating to the piece of data, transmits the information to the LU Engine, receives identifying information from the LU Engine, and exchanges the identifying information on the data bus together with the piece of data.

46. A method according to claim 44, wherein the data and identifying information is stored subsequent to receipt of the identifying information and prior to exchange thereof on the data bus.

47. A method according to claim 44, wherein at least one fourth device determines, on the basis of the identifying information, whether the data is addressed for the device or not.

48. A method according to claim 44, wherein the arbiter determines, when more than one port or device is to receive a piece of data received at a receiving device, which of the ports and devices are available or non-congested and transmit information to the receiving device in order to have it forward the data to those ports and devices, and subsequently, when other of the ports or devices are available or non-congested, informs the receiving device to forward the data to those devices or ports.

49. An interface comprising:

- a plurality of means for serializing parallel data, each serializing means being adapted to output a serial data signal,
- first means for providing a plurality of independent first parallel data, one first parallel data for each serializing means,
- second means for providing second parallel data, for dividing the second parallel data into a plurality of third parallel data and for providing a third parallel data to each of the serializing means, and

- means for aligning and/or synchronizing serial data signals output from the serializing means in order to obtain a predetermined timing relationship between the plurality of serial data signals.

50. An interface according to claim 49, wherein the aligning/synchronizing means are adapted to not align/synchronize serial data signals output from the serializing means when receiving the first parallel data.

51. An interface comprising:

- a plurality of means for serializing parallel data, each serializing means being adapted to output a serial data signal,
- first means for providing a plurality of independent first parallel data, one first parallel data for each serializing means,
- second means for providing second parallel data, for dividing the second parallel data into a plurality of third parallel data and for providing a third parallel data to each of the serializing means, and
- means for aligning and/or synchronizing the third parallel data in order to obtain a predetermined timing relationship between the plurality of third serial data signals.

52. An interface according to claim 49, wherein the aligning/synchronizing means are adapted to be disabled.

53. An interface according to claim 49, wherein the first providing means is adapted to output each first parallel data along a first parallel data bus having a first predetermined number of conductors, wherein the second providing means is adapted to output the second parallel data along a second data bus having a second predetermined number of conductors, and wherein the first and second data busses have at least one conductor in common.

54. An interface according to claim 53, wherein the first predetermined number of conductors differs from the second number of conductors.

55. An interface according to claim 53, wherein the first parallel data busses are comprised in the second parallel data bus.

56. An interface according to claim 53, wherein the plurality of serializing means times the first predetermined number of conductors is identical to the second predetermined number of conductors.

57. An interface according to claim 49, wherein the first providing means is adapted to output first parallel data conforming to the GMII standard, wherein the second providing means is adapted to output second parallel data conforming to the XGMII standard, and wherein the serializing means are adapted to output a plurality of serial data signals conforming to the XAUI or the Infiniband standards.

58. An interface comprising:

- a plurality of means for each receiving a serial data signal and for deserializing the serial data signal into parallel data,
- means for aligning/synchronizing the serial data signals prior to deserialization in order to obtain a predetermined timing relationship between the plurality of parallel data, the aligning/synchronizing means being adapted to be disabled,
- means for, when the aligning/synchronizing means are not disabled, combining the parallel data relating to deserialized aligned/synchronized serial signals into a single parallel piece of data or a single parallel stream of data.

59. An interface comprising:

- a plurality of means for each receiving a serial data signal and for deserializing the serial data signal into parallel data,
- means for aligning/synchronizing the plurality of parallel data in order to obtain a predetermined timing relationship between the plurality of parallel data, the aligning/synchronizing means being adapted to be disabled,
- means for, when the aligning/synchronizing means are not disabled, combining the aligned/synchronized parallel data into a single parallel piece of data or a single parallel stream of data.

60. An interface according to claim 58, wherein the deserializing means are adapted to output each parallel data along a first parallel data bus having a first predetermined number of conductors, wherein combining means is adapted to output the single parallel data along a second data bus having a second predetermined number of conductors, and wherein the first and second data busses have at least one conductor in common.

61. An interface according to claim 60, wherein the first predetermined number of conductors differs from the second number of conductors.

62. An interface according to claim 60, wherein the first parallel data busses are comprised in the second parallel data bus.

63. An interface according to claim 60, wherein the plurality of deserializing means times the first predetermined number of conductors is identical to the second predetermined number of conductors.

64. An interface according to claim 58, wherein the deserializing means are adapted to output first parallel data conforming to the GMII standard, wherein the combining means is adapted to output second parallel data conforming to the XGMII standard, and wherein the deserializing means are adapted to receive a plurality of serial data signals conforming to the XAUI or the Infiniband standards.

65. An interface according to claim 49, further comprising a means for providing a clocking signal, and wherein the serializing/deserializing means are adapted to perform the serializing/deserializing in accordance with the clocking signal.

66. An interface according to claim 65, wherein the clocking providing means are adapted to provide a clocking signal having one of two clocking signal frequencies, where a clocking signal having one of the clocking signal frequencies is provided when the aligning/synchronizing means is disabled and the other when the aligning/synchronizing means is not disabled.

67. An interface according to claim 66, wherein the one and the other clocking frequencies are selected from the group consisting of 3.25 GHz, 1.25 GHz, and 2.5 GHz.

68. An interface according to claim 67, wherein the frequency of the one signal is 1.25 GHz and wherein frequency of the other signal is 3.25 GHz or 2.5 GHz.

69. A communication system comprising a first interface according to claim 49 and a second interface according to any of claims 58-64 and means for transporting the plurality of serial signals from the first interface to the second interface, the system comprising means for processing the plurality of parallel data and/or the single parallel data output by the second interface, the processing means being adapted to process the plurality of parallel data independently of each other.

70. A communication system according to claim 69, the system being adapted to be operated in one of two modes of operation, comprising:

- a first mode of operation wherein the aligning/synchronizing means of the first and second interfaces are operated, and
- a second mode of operation wherein the aligning/synchronizing means of the first and second interfaces are disabled.

71. A method of operating the interface of claim 49, the method comprising:

- determining whether the serial data signal(s) to be received and/or output is/are to be aligned and/or synchronized and
- operating the aligning/synchronizing means accordingly.

72. A method according to claim 71, wherein the determining step comprises determining an overall data rate of the plurality of serial data signals and operating the aligning/synchronizing means if the data rate exceeds a predetermined threshold.

73. A method of operating the interface according to claim 58, the method comprising: altering between two modes of operation wherein:

- in a first mode of operation, the deserializing means receive data independently of each other and output the parallel data independently of each other, and
- in a second mode of operation, the single parallel data is output.

74. A method of operating the interface according to claim 49, the method comprising: altering between two modes of operation wherein:

- in a first mode of operation, the serializing means receive the first parallel data independently of each other and output the serial data independently of each other, and
- in a second mode of operation, the plurality of serial data signals output have the predetermined timing relationship.

75. A switch having:

- a number of devices each comprising an interface **according to claim 49** and an interface comprising a plurality of means for each receiving a serial data signal and for deserializing the serial data signal into parallel data, means for aligning/synchronizing the serial data signals prior to deserialization in order to obtain a predetermined timing relationship between the plurality of parallel data, the aligning/synchronizing means being adapted to be disabled, means for, when the aligning/synchronizing means are not disabled, combining the parallel data relating to deserialized aligned/synchronized serial signals into a single parallel piece of data or a single parallel stream of data and each being adapted to receive a plurality of serial data signals from and output a plurality of serial data signals to one or more network connections,
- a data bus on which the devices are adapted to interchange data,

wherein at least one of the devices is adapted to alter between at least two modes of operation comprising:

- a first mode of operation wherein the device is adapted to receive serial data signals from and transmit serial data signals to a first number of network connections via the interface, and
- a second mode of operation wherein the device is adapted to receive serial data signals from and transmit serial data signals to a second number of network connections via the interface, the second number being higher than the first number.

76. A switch according to claim 75, wherein the at least one device comprises a processing means adapted to process the data received from the interface before transmission to the data bus, the processing means being adapted to alter between operation in one of at least two modes of operation comprising:

- a first mode of operation wherein the means is adapted to process the data from each of the first number of network connections independently of each other, and
- a second mode of operation wherein the means is adapted to process the data from the second number of network connections independently of each other.

77. A switch according to claim 76, wherein the processing means comprises, in the second mode of operation, separate memory for each of the second number of independent processes and logic shared between the second number of independent processes.

78. A switch according to claim 75, wherein at least one device further comprises a storage means adapted to store data between receipt thereof at the interface and transmission thereof on the bus, the storage means being adapted to alter between at least two modes of operation comprising:

- a first mode of operation for use when the device operates in its first mode of operation and wherein the storage means is adapted to store received data in a number of queues corresponding to the first number of network connections times a first predetermined number, and
- a second mode of operation for use when the device operates in its second mode of operation and wherein the storage means is adapted to store received data in a number of queues corresponding to the second number of network connections times a second predetermined number.

79. A method of operating a switch having:

- a number of devices each comprising an interface **according to claim 49** and an interface comprising a plurality of means for each receiving a serial data signal and for deserializing the serial data signal into parallel data, means for aligning/synchronizing the serial data signals prior to deserialization in order to obtain a predetermined timing relationship between the plurality of parallel data, the aligning/synchronizing means being adapted to be disabled, means for, when the aligning/synchronizing means are not disabled, combining the parallel data relating to deserialized aligned/synchronized serial signals into a single parallel piece of data or a single parallel stream of data and each

being adapted to receive a plurality serial data signals from and output serial data signals to one or more network connections via the interface,

- a data bus on which the devices are adapted to interchange data,

the method comprising altering, in at least one of the devices, between at least two modes of operation comprising:

- a first mode of operation wherein the device receives serial data signals from and/or transmits serial data signals to a first number of network connections via the interface, and
- a second mode of operation wherein the device receives serial data signals from and/or transmits serial data signals to a second number of network connections via the interface, the second number being higher than the first number.

80. A method according to claim 79, further comprising the step of processing the data received from the interface before transmission to the data bus, the method comprising altering the processing between at least two modes of operation comprising:

- a first mode of operation wherein the data from each of the first number of network connections is processed independently of each other, and
- a second mode of operation wherein the data from the second number of network connections is processed independently of each other.

81. A method according to claim 79, further comprising the step of storing data between receipt thereof at the interface and transmission thereof on the bus, the method comprising altering the storing between at least two modes of operation comprising:

- a first mode of operation for use when the device operates in its first mode of operation and wherein data is stored in a number of queues corresponding to the first number of network connections times a first predetermined number, and
- a second mode of operation for use when the device operates in its second mode of operation and wherein received data is stored in a number of queues corresponding to the second number of network connections paths times a second predetermined number.

82. A method of operating the switch according to claim 75, the method comprising:

- determining, for at least one of the devices, whether to use the first or the second mode of operation, and
- operating the device in the mode of operation determined.

83. A switch having:

- a number of devices each comprising an interface comprising a plurality of means for serializing parallel data, each serializing means being adapted to output a serial data signal, first means for providing a plurality of independent first parallel data, one first parallel data for each serializing means, second means for providing second parallel data, for dividing the second parallel data into a plurality of third parallel data and for providing a third parallel data to each of the serializing means, and means for aligning and/or synchronizing serial data signals output from the serializing means in order to obtain a predetermined timing relationship between the plurality of serial data signals and an interface **according to claim 58** and each being adapted to receive a plurality of serial data signals from and output a plurality of serial data signals to one or more network connections,
- a data bus on which the devices are adapted to interchange data,

wherein at least one of the devices is adapted to alter between at least two modes of operation comprising:

- a first mode of operation wherein the device is adapted to receive serial data signals from and transmit serial data signals to a first number of network connections via the interface, and
- a second mode of operation wherein the device is adapted to receive serial data signals from and transmit serial data signals to a second number of network connections via the interface, the second number being higher than the first number.

84. A method of operating a switch having:

- a number of devices each comprising an interface comprising a plurality of means for serializing parallel data, each serializing means being adapted to output a serial data signal, first means for providing a plurality of independent first parallel data, one first parallel data for each serializing means, second means for providing second parallel data, for dividing the second parallel data into a plurality of third parallel data and for providing a

third parallel data to each of the serializing means, and means for aligning and/or synchronizing serial data signals output from the serializing means in order to obtain a predetermined timing relationship between the plurality of serial data signals and an interface **according to claim 58** and each being adapted to receive a plurality serial data signals from and output serial data signals to one or more network connections via the interface,

- a data bus on which the devices are adapted to interchange data,

the method comprising altering, in at least one of the devices, between at least two modes of operation comprising:

- a first mode of operation wherein the device receives serial data signals from and/or transmits serial data signals to a first number of network connections via the interface, and
- a second mode of operation wherein the device receives serial data signals from and/or transmits serial data signals to a second number of network connections via the interface, the second number being higher than the first number.